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Overview of the National Wood In Transportation Program's Portable Timber Bridge Activities

One segment of the National Wood In Transportation (NWIT) program has been to develop partnerships that lead to the development and demonstration of simple, dependable, and economical portable timber bridge designs used for timber harvesting operations and other temporary stream crossing applications. One of the primary purposes for these projects is to find solutions for minimizing the environmental impacts to streams during times of temporary crossings. To date, the program has funded eight portable timber bridge projects. Three of these projects are highlighted below. In addition, the USDA Forest Service has developed a lightweight portable timber bridge design for use on skidder trails. The enclosed fact sheet highlights this effort.

Portable timber bridge projects:

- ***The Development and Testing of Glulam Portable Timber Bridge Designs*** — Auburn University, Department of Agricultural Engineering, Auburn, AL

The objective of the work at Auburn was to develop timber bridge designs for temporary stream crossings such as those encountered on logging roads and skid trails. Cooperating with the USDA Forest Service and with several industry partners, Auburn developed and tested several different designs of portable bridges using glued-laminated timbers. These bridges include several prototypes for truck traffic and one for off-highway vehicles like wheeled skidders. These bridges have been tested and monitored for performance and longevity in typical forest harvesting operations. In addition to constructing and monitoring the prototype designs, test data were used to develop information that can be used to help in the design of future portable timber bridges. Currently, at least one manufacturer of glued-laminated timbers is fabricating and

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Visit our website at www.fs.fed.us/na/wit



Overview of Portable Timber Bridge Activities . . . continued from page 1

marketing these types of portable bridges. For additional information about this project, contact: Steve Taylor, Auburn University, at 334-844-3534, or visit the following website: http://www.eng.auburn.edu/users/staylor/timber_bridges.html.

■ **The Development and Testing of Stress-Laminated Portable Timber Bridge Designs** — West Virginia University, Morgantown, WV

The objective of this project was similar to the project objectives listed previously, except the basic design concept used stress-lamination. An effective bridge design was developed and demonstrated. A business in Morgantown is currently manufacturing and marketing this type of bridge in 30-foot and 40-foot lengths. For information about this effort, contact Curt Hassler, Clear Creek Crossings, LLC, at 304-291-3962.

A publication titled, *Portable Timber Bridges: An Eco-friendly Solution for Stream Crossings*, documents this effort. It is available through the National Wood In Transportation Information Center at 304-285-1591 and request publication number WIT-02-0038. The publication can be viewed on the Web at <http://www.fs.fed.us/na/wit/pdf/portab~1.pdf>.

■ **New York City Watershed Forestry Temporary Bridge Program** — Watershed Agricultural Council, Walton, NY

The objective of this project was to encourage the adoption of temporary bridges as a timber harvest best management practice in the New York City watershed. Emphasis was placed on the development and/or demonstration of bridges used for skidder trails and haul road applications. To date, a skidder bridge design has been developed and demonstrated. Approximately three small businesses are currently manufacturing and marketing these types of bridges. At least one stress-laminated portable timber bridge for use on haul roads has been demonstrated and promoted. For additional information about the program, contact Justin Perry, Watershed Agricultural Council, at 607-865-7790 or visit the following website: <http://www.nycwatershed.org/forest.htm>.

Results of the Ninth National Timber Bridge Student Design Competition

Nine teams of students from universities across the United States matched wits during the Ninth National Timber Bridge Student Design Competition. Open to student chapters of the American Society of Civil Engineers (ASCE) and Forest Products Society (FPS), the competition was made possible by a grant from the USDA Forest Service, Wood In Transportation program. The Southern Pine Council of the Southern Forest Products Association, Unit Structures LLC, and Willamette Industries provided additional financial support. Southwest Mississippi Resource Conservation and Development (RC&D), Inc., coordinated the annual competition.

Each team designed, constructed, and tested their bridges on their home campus, then submitted documentation of their activities and results to a panel of judges for review. The competition was conducted online via the Internet. Each team was required to post design drawings, test results, and project highlights on the Web at www.msacd.org (www.msacd.org/bridge.htm). To view details of competition results and to access each entry in its entirety, click on "2001 Competition Results."

Winner of the **Best Overall Design Award** sponsored by Willamette Industries was the **Mississippi State University ASCE Chapter**. Their design used multiple members in both tension and compression to minimize weight and deflection. A 1-inch by 4-inch tongue and groove deck was supported by seven glued-laminated longitudinal stringers. Four steel cable assemblies were added to limit tension in the bridge. All wood members were southern pine treated with bromated copper arsenate at 0.40 pounds per cubic foot. This entry also placed *second* in **Best Deck Performance** and *second* in **Most Aesthetic Design**. The Team received cash awards totaling \$2,350 for their efforts.

Top money winner was the **United States Military Academy ASCE Chapter** with awards totaling \$2,500. Their entry placed *first* in **Best Deck Performance** and **Most Practical Design** and *second* place in **Best Support Structure Performance** and the **Willamette Industries Best Design**. Their design featured a transverse deck of 2-inch by 6-inch CCA-treated southern pine ship-lapped and edge-glued. The deck was supported by three longitudinal parallel trusses built of southern pine 2-inch by 4-inch lumber using standard nail plates. Their goal was practicality and speed of construction, combined with strength and lightweight.

Continued Page 3

Ninth National Timber Bridge Student Design Competition . . . *continued from page 2*

The ASCE Chapter of Washington University at St. Louis was another big winner, receiving \$2,000 for *first* place in **Best Support Structure Performance**, *second* in **Most Practical Design**, and *third* in **Best Design** and **Best Deck Performance**. Their twin composite I-beam structure used CCA-treated southern pine with 2-inch by 6-inch transverse stiffeners spanned by a longitudinal deck of southern pine 2-inch by 6-inch planks.

The final first-place entry was produced by **San Jose State University's ASCE Chapter**. Their above-deck parallel-chord trusses combined with longitudinal 2-inch by 6-inch Douglas fir deck caught the eyes of all three judges to win *first* place as **Most Aesthetic**. Adding two *third* place awards in **Most Practical Design** and **Best Support Structure** brought their total awards to \$1,350.

The Virginia Polytechnic Institute and State University's Forest Products Society Chapter captured *first* place for the **Most Innovative Design** for their arch-suspension bridge. Clarkson University and Oklahoma State settled for a *second* place tie in this category.

Other teams competing in the competition included Merrimack College ASCE and Rose-Hulman Institute of Technology ASCE.

For a complete review of competition results and each individual entry, go to www.msacd.org and follow the links. Results of 2000, 1999, and 1998 competitions are also posted online. The 2002 Competition begins in September 2001 with rules being posted on the website in late August 2001. For additional information, contact Southwest Mississippi RC&D, Inc., 747 Industrial Park Road, NE, Brookhaven, MS 39601. Phone: 601-833-5539, Fax: 601-835-0054, e-mail: southwest@msacd.org, or visit the Wood In Transportation website at www.fs.fed.us/na/wit.

The competition's objectives are to promote interest in the use of wood as a competitive bridge construction material, to generate innovative and cost-effective timber bridge design techniques, and to develop an appreciation of the engineering capabilities of wood among future transportation and forest products engineers. Following the competition, most of the bridges are placed into use as trail bridges for pedestrians, horses, snow mobiles, etc.

The test bridges were 13 feet long and 4 feet wide and were loaded with a test weight of approximately 4,500 pounds. Average weight of the bridge models was 722 pounds. At full loading, maximum bridge deflection ranged from 4.42 mm to 9.91 mm. Maximum allowable deflection was 10 mm.

Net deck deflection for the three bridges that met the maximum allowable deflection of deck span divided by 400 averaged 74 percent of maximum allowable. Percent non-wood materials in the bridges averaged 8.5 percent; maximum percent non-wood materials allowed was 25 percent by weight. A total of 68 students spent 1,583 hours on the competition, competing for \$10,000 in prizes. Judges for the competition were Bert Lovell, Willamette Industries; Nelson Hernandez, USDA Forest Service; and Shannon McCarty, USDA Natural Resources Conservation Service.

— **Bennie F. Hutchins**
RC&D Coordinator
Southwest Mississippi RC&D, Inc.



Design of Wood Highway Sound Barriers

As new and existing United States residential areas and high volume highways continue to intermingle, traffic noise abatement procedures continue to be important. This study investigated the acoustic effectiveness, public acceptance, and structural requirements of various designs and types of sound barriers. In addition, the acoustic effectiveness of a prototype sound barrier is reported. Results are presented on the acoustic effectiveness from in situ measurements of one cement bonded composite panel barrier and four precast concrete, two plywood, two glued-laminated, and three post and panel barriers. The research on public acceptance of sound barriers focused on the perception of visual compatibility. Based on results from semantic-differential and individual ratings, wood and concrete barrier designs were perceived to have favored "rural" qualities. Data collected during the research on acoustic effectiveness and public acceptance were used to develop structural requirements and construction details for a prototype wood sound barrier. The prototype wood sound barrier provided insertion losses of 15 dB or greater, exceeding the 10-dB acceptable performance for a highway sound barrier.

To obtain a copy, please contact the National Wood In Transportation Information Center at 304-285-1591 and request publication number *WIT-02-0062* or visit the Wood In Transportation website at www.fs.fed.us/na/wit; click on "New Publications Available".

NEW PUBLICATIONS

Field Performance of Timber Bridges

21. Humphrey Stress-Laminated T-Beam Bridge

The Humphrey Bridge was constructed during the summer and fall of 1993 in Cattaraugus County, New York. The bridge is a single-span, stress-laminated T-beam structure that measures 14.1 m (48.6 ft) long and 10.2 m (33.5 ft) wide. Performance of the bridge was monitored for 35 months, beginning approximately eight months after installation. Monitoring involved gathering and evaluating data relative to the moisture content of the wood components, force level of the stressing bars, and behavior of the bridge under static load conditions. In addition, comprehensive visual inspections were conducted to assess the overall condition of the structure. Based on field evaluations, the bridge is performing well, with only a few minor serviceability issues.

To obtain a copy, please contact the National Wood In Transportation Information Center at 304-285-1591 and request publication number *WIT-06-0042*, or visit the Wood In Transportation website at www.fs.fed.us/na/wit; click on "New Publications Available".



Analysis of Thermal Change in Stress- Laminated Timber Bridge Decks

As the timber bridge design has evolved, some engineers have been concerned about the integrity of the stress-laminated system in cold climates. The structural integrity of a stress-laminated bridge depends on the level of interlaminar compression (between the wood laminations). Temperature change can cause material shrinkage, which could lead to substantial performance problems based on material mechanics and the nature of the stress-laminated system. In this study, to determine the effects of thermal change on interlaminar compression, four stress-laminated timber deck sections were put through a warm-cold-warm cycle. Various interlaminar stress levels and three moisture content levels were tested. Results showed that interlaminar compression in stress-laminated decks of this size was not affected by extremely cold temperatures when the moisture content was less than 19 percent and when initial bar force was sufficient.

To obtain a copy, please contact the National Wood In Transportation Information Center at 304-285-1591 and request publication number *WIT-06-0041*, or visit the Wood In Transportation website at www.fs.fed.us/na/wit; click on "New Publications Available".

Article contributions, questions, or comments may be sent to Ed Cesa, Program Coordinator, National Wood In Transportation Information Center or Mr. Chris Grant, Program Assistant, USDA Forest Service, 180 Canfield Street, Morgantown, WV 26505; Phone: (304) 285-1591; FAX: 304-285-1587, or e-mail cgrant@fs.fed.us. A change of address may also be submitted to cgrant@fs.fed.us. For publication requests, e-mail jnorth@fs.fed.us.

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A Portable Skidder Timber Bridge Design



The USDA Forest Service San Dimas Technology and Development Center (SDTDC) and the Wood In Transportation (WIT) Program have developed a portable/temporary skidder bridge to cross drainages for field harvesting equipment. Its length is 16 feet, and width is 12 feet. It is constructed using three 4-foot-wide preconstructed laminated panels. The exterior panels have 8-inch wide by 8-inch high curbs making the travelway width 10 feet 8 inches. The bridge is designed to carry a 27,000-pound axle load, which equates to a Caterpillar 525 Skidder with an 8,000-pound grapple load. One major goal of this project was to design a lightweight easy to install bridge that would aid in minimizing erosion and sedimentation at stream crossings.

The panels are preassembled, and field equipment, such as a skidder can be used to install the bridge. The bridge rests on 4-inch by 8-inch sills. Each sill has guide plates to secure the panels in place.

Acceptable species and grades are shown in table 1. Any species of wood may be used providing its unfactored bending strength is at least 875 pounds per square inch. SDTDC evaluated bolted panels, but the panels can be glued or nail laminated (see note 1).

This bridge is structurally adequate for 3- or 5-axle log trucks. However, due to its narrow width, minimal curb system, and large live load deflection, log truck traffic should be limited to occasional trucks operating at low speeds.

Dynamic effects caused by rough approaches, or bumps at the ends of bridges, can significantly increase wear and damage to bridges. Approaches to bridges should be initially graded and maintained at a relatively smooth and level surface.

This project was completed by: James R. Bassel, Project Leader, USDA Forest Service, San Dimas, CA
Merv Eriksson, Structural Engineer, USDA Forest Service, Missoula, MT

For additional information, visit the Wood In Transportation website at www.fs.fed.us/na/wit, or call the National Wood In Transportation Information Center at (304) 285-1591.



USDA Forest Service



San Dimas Technology
and Development Center



Wood In Transportation

FIELD EVALUATION

The Homochitto National Forest in Mississippi evaluated this design. The Forest used red oak common to the area. The bridge has been used on three different sales and has carried more than a million board feet of timber. The Forest was pleased that the drainages were not disturbed, and the contractor was able to save time by traveling over the drainages rather than around them.

Two men assembled the bridge panels in two days. Installation of the bridge panels at the site takes two men 30 minutes using standard field equipment.

Approximate Material Cost:

| | |
|----------|------------|
| Wood | \$1,500.00 |
| Hardware | 150.00 |
| Total | \$1,650.00 |

Forest Contact:

Lee Dunnan
National Forests in Mississippi
Homochitto Ranger District
Rt. 1, Box 1
Meadville, MS 39652
(601) 384-5876

SKIDDER BRIDGE MATERIAL LIST For Three Bolted 4-foot Panels using 4-inch by 8-inch Timbers

Timber

Note: The design requires a bridge depth of 8 inches. Any width timbers that have that depth can be used (e.g., 2-in by 8-in, 3-in by 8-in, etc.). SDTDC used 4-inch by 8-inch timbers. Exterior laminations must be 4 inches thick due to countersinking.

| | |
|----|--|
| 40 | 4-in by 8-in by 16 feet rough sawn timber (see Table 1) |
| 2 | 4-in by 8-in by 12 feet rough sawn timber for sills (can use 16 feet length) |

Hardware for 4-foot panels

| | |
|----|---|
| 24 | 3/4-inch by 4-foot rods with threads, 6 inches each end |
| 48 | 3/4-inch nuts (heavy hexagon) |
| 48 | 3/4-inch malleable iron washers |

Hardware for curbs

| | |
|----|---------------------------------|
| 8 | 3/4-inch by 18-inch bolts |
| 8 | 3/4-inch nuts (heavy hexagon) |
| 16 | 3/4-inch malleable iron washers |

Hardware for sill

| | |
|----|---------------------------------|
| 12 | 3/4-inch by 10-inch lag bolts |
| 12 | 3/4-inch malleable iron washers |

Total Materials for Skidder Bridge

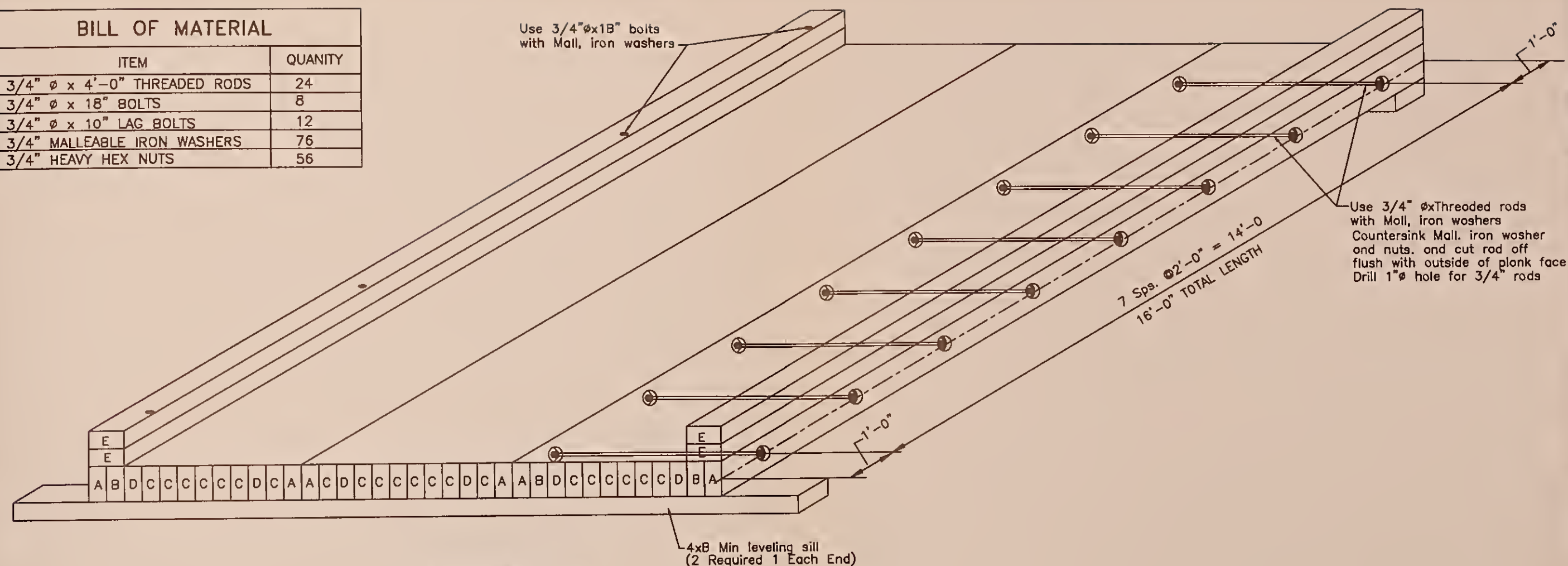
| | |
|----|---|
| 42 | 4-in by 8-in by 16 feet rough sawn timber (using 16 feet for sills) |
| 24 | 3/4-inch by 4-foot rods with threads, 6 inches each end |
| 8 | 3/4-inch by 18-inch bolts |
| 56 | 3/4-inch nuts (heavy hexagon) |
| 76 | 5/8-inch malleable iron washers |
| 12 | 3/4-inch by 10-inch lag bolt |

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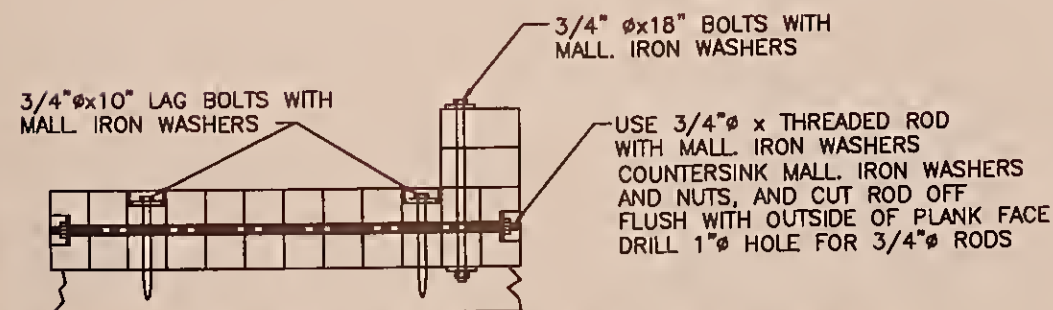
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| BILL OF MATERIAL | |
|-----------------------------------|----------|
| ITEM | QUANTITY |
| 3/4" ϕ x 4'-0" THREADED RODS | 24 |
| 3/4" ϕ x 18" BOLTS | 8 |
| 3/4" ϕ x 10" LAG BOLTS | 12 |
| 3/4" MALLEABLE IRON WASHERS | 76 |
| 3/4" HEAVY HEX NUTS | 56 |

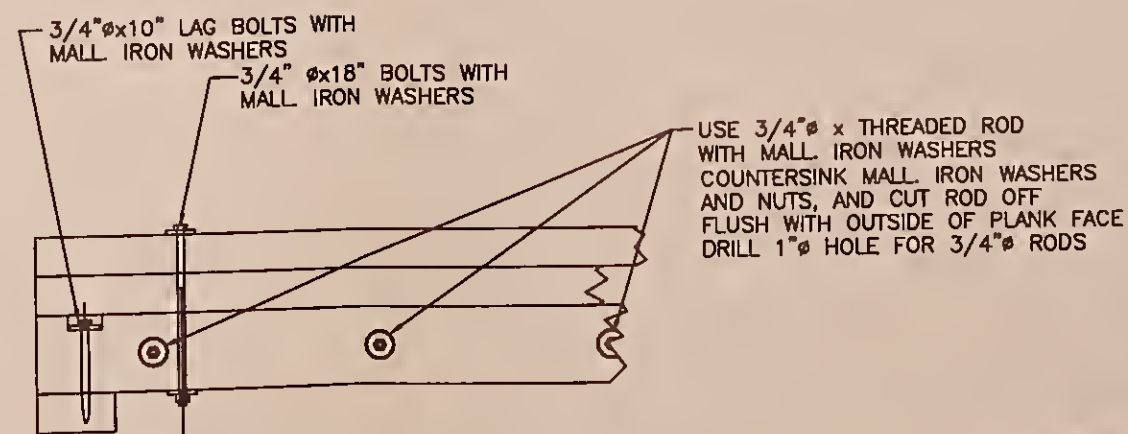


BOLTED PANELS
3 PANELS 4'-0" WIDE

These plans are intended for informational purposes only and must be verified by a registered professional engineer prior to construction.



SECTION THROUGH DECK BEAM NEAR ABUTMENT

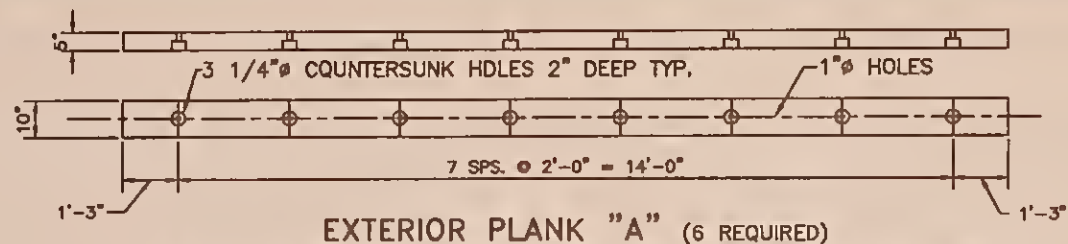


ABUTMENT ELEVATION

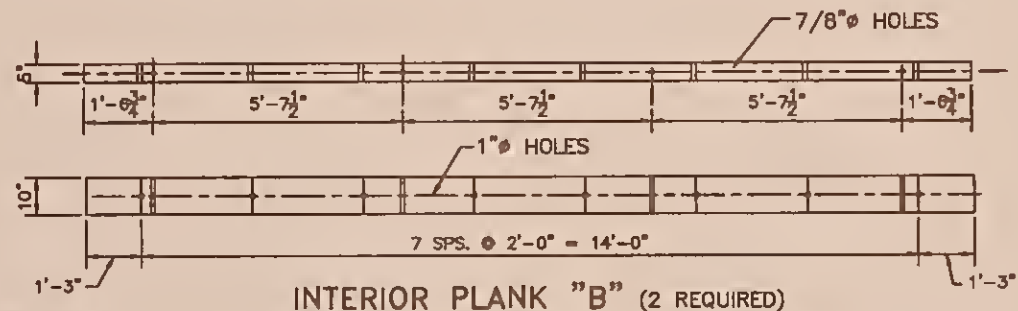
SKIDDER BRIDGE

| | | |
|------------------------------|----------------|-----------------------------|
| Designed By: <i>W. A. S.</i> | Date: 2/9/2001 | DRAWING NO. SHEET 1 OF 2 |
| Approved By: . | Date: . | |

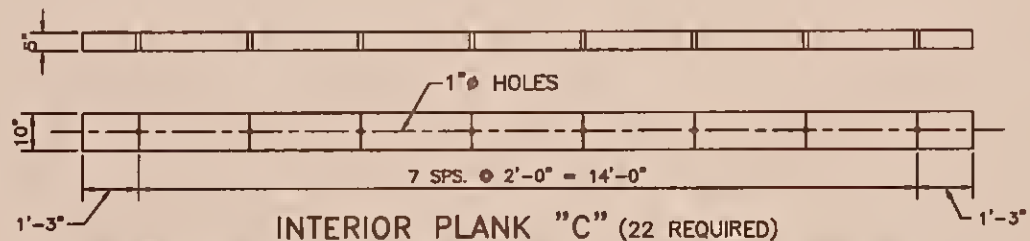
SKIDDER BRIDGE NOTES:



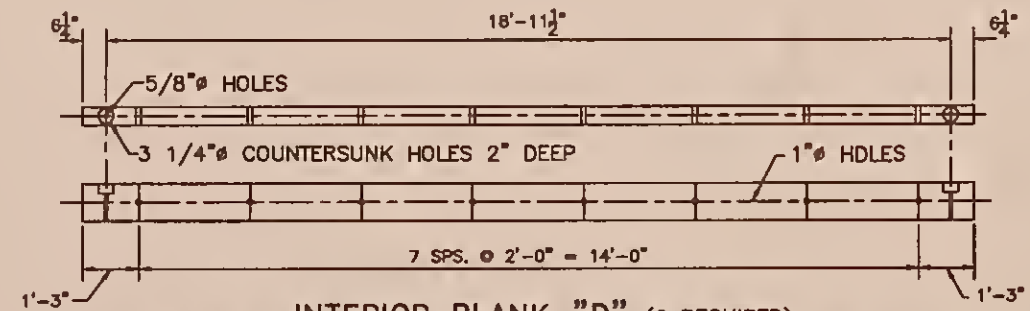
PLANK A is the exterior lamination for each panel edge. It has 8 countersunk holes through its wide face.



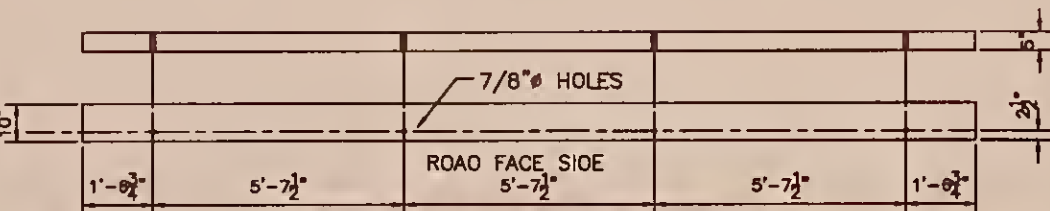
PLANK B is the second lamination from the outside in each exterior panel. It has 8 holes through its wide face and 4 vertical curb bolt holes through its narrow face.



PLANK C is an interior lamination. It has 8 holes through its wide face.



PLANK D is an interior lamination. It has 8 holes through its wide face and 2 countersunk vertical sill lag bolt holes through its narrow face.



CURB PLANK "E" (4 REQUIRED)

PLANK E is the curb lamination. It has 4 offset curb bolt holes through its wide face.

1. BRIDGE PANELS: Three panels, 48 inches wide shall be fabricated from 4-inch thick by 8-inch wide laminations. Exterior panels shall have 8-inch wide by 8-inch high guide curbs as shown. The panels are shown bolted together.

The panels can also be glued laminated or nail laminated. If glued laminated, the panels shall be fabricated in conformance with AASHTO M168 and ANSI/AITC A190.1 and shall be manufactured to an industrial appearance using wet-use adhesives.

If nail laminated, each lamination shall be nailed using 10-inch deformed shank bridge spikes having a minimum shank diameter of 3/8" in pre-drilled 1/4" diameter holes. The spikes shall be spaced at 12 inches and staggered at 2 inches from the top and bottom of the planks.

2. WOOD SPECIES AND GRADES: Any species of wood may be used providing its tabulated, or unadjusted, allowable bending stress is not less than 875 pounds per square inch. Examples of acceptable species and grades are shown in Table 1. Expected use and expected life span should be considered when selecting a species. High volumes of skidded timber may require a hard, high-density species.

3. PRESERVATIVES: If the panels are to be used more than 1 or 2 years the timber should be pressure treated with an approved preservative. The timber shall be treated in conformance with AWPA C14 (soil contact) and the Best Management Practices for the Using Treated Wood in Aquatic and Wetland Environments. Insofar as is practical, all lumber shall be cut, drilled, and completely fabricated prior to pressure treatment.

4. DESIGN LOADS: These bridges are designed to carry a 27,000-pound skidder axle load. This skidder load corresponds to a Cot 525 with an 8,000-pound gross load. The bridge will also support an AASHTO Type 3 Truck (3-axle dump truck), an AASHTO Type 3-S2 Truck (5-axle logging truck), an AASHTO HS 20 Truck (highway load vehicle), or a truck mounted vehicle having a load, per truck, of up to 1,300 pounds per linear foot. The bridge is designed assuming exclusively the exterior panels carry all wheel and truck loads. Larger skidder or truck mounted vehicle loads, or overweight trucks, will require redesigned panels or shorter spans.

5. DESIGN LIMITATIONS: Although the bridge is structurally adequate for standard highway 3- or 5-axle trucks, because of the narrow width, minimal height curb system, and large live load deflections; truck traffic should be limited to occasional trucks operating at low speeds (10 miles per hour or less).

6. DYNAMIC LOADING: Dynamic effects caused by rough approaches, or bumps at the ends of the bridge can significantly increase live loading, resulting in excessive wear and damage to the bridge. Approaches to bridges should be graded, and maintained as a level-riding surface.

7. HARDWARE: Malleable iron washers shall be used under all nuts and bolt heads unless the bolts are timber or dome head. Bolts and lag bolts shall comply with the requirements of ANSI/ASME Standard B18.2.1-1981, Grade 2. Any other steel components shall comply with ASTM A36.

8. INSTALLATION AND REMOVAL: Bridge panels may be prefabricated or assembled in place. Panels should be placed on, and attached to, the leveling sills as shown. Foundations should be leveled and compacted as necessary to provide a solid bearing surface for the leveling sill. Timber members and panels should be stored and handled so as not to damage the material. If damage does occur, exposed untreated wood should be field treated in accordance with AASHTO M 133.

TABLE 1

| SPECIES GROUPS | VISUAL GRADE* | EXT. PANEL WEIGHT (lbs)** |
|-----------------|-------------------|---------------------------|
| Cottonwood | Select Structural | 1,750 |
| Doug Fir/Larch | No. 2 | 2,200-2,350 |
| Hemlock/Fir | No. 1 | 1,500-2,150 |
| Red Maple | No. 1 | 2,450 |
| Southern Pine | No. 2 | 2,300-2,600 |
| Spruce/Pine/Fir | No. 1 | 1,750-2,050 |
| Western Woods | Select Structural | 1,750-2,350 |

* Lumber must be graded.
** Weights assume creosote treatment and 20% moisture content.
Weights vary in multiple species groups.

These plans are intended for informational purposes only and must be verified by a registered professional engineer prior to construction.

SKIDDER BRIDGE

Designed By: *W. A. S. L.* Date: 2/9/2001
Approved By: *W. A. S. L.* Date: *2/9/2001*
DRAWING NO. SHEET 2 OF 2